TRAINING CURRICULUM: LABORATORY SUPPLY LOGISTICS

GOAL

Introduce participants to issues related to supply chain management in support of essential laboratory services.

LEARNING OBJECTIVES

By the end of the session, participants will be able to—

1. Define common terms used in laboratory services, and identify and describe the different commodity classifications that are used in laboratory services.
2. Describe the key points that a national policy document should have that applies to the management of laboratory supplies (including the concept of test menus and test techniques by level, quality assurance/quality control (QA/QC) schemes, and the regulatory framework for laboratory services); and the implications the policies have on supply chain management.
3. Describe the importance of standardized operating procedures for laboratory logistics.
4. Describe similarities and differences in a logistics management information system (LMIS) for laboratory supply management compared with an LMIS for other health commodities.
5. Identify challenges in forecasting and quantifying needs for laboratory supplies and factors that should be taken into account when doing these activities.

TIME

8 hours (6.5 hours for class, 1.5 hours for breaks).

MATERIALS

POSTERS:

1. Class schedule
2. Parking lot
3. Definitions for reagents, consumables, and durables.

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POWERPOINT SLIDES:
Laboratory Supply Logistics (nine slides). See the PPT file listed beside this document on the CD.

HANDOUTS:
1. Session goal and objectives
2. Example of basic laboratory tests and commodities
3. Sample test menu and techniques by level
4. Blank answer form for commodity classification activity
5. Answer sheet for commodity classification activity
6. Photo glossary
7. Laboratory logistics glossary
8. Quiz for key laboratory terms
9. Answer sheet for key laboratory terms quiz
10. Summary of LMIS records and reports
11. Part 1 of LMIS activity
12. Part 2 of LMIS activity
13. Part 3 of LMIS activity
14. Considerations and recommendations for laboratory LMIS
15. Manual hemoglobin techniques and commodities.

FACILITATOR PREPARATION FOR ACTIVITIES

LABORATORY COMMODITY CLASSIFICATION ACTIVITY
Facilitator(s) should prepare three stations in the room, each with 10 identical laboratory items (i.e., each station should have the same 10 laboratory commodities). The 10 commodities should be labeled to match the number and name of the items on handouts 4 and 5. The 10 commodities should be a variety of consumables, durables, and reagents. The reagents should be representative (i.e., use colored water, bottles with sand, sugar, Kool-Aid, etc.). Be sure to label the reagent bottles. If durables are not available, the facilitator should use photographs. Examples of these commodities are—

- Consumables: pipette tips, lancets, microscope slides, vacutainers and needles, bleach
- Reagents: stains, agar mediums, chemistry kits
- Durables: reusable glassware, microscope, microscope bulb.

The handouts provided show sample names that may be replaced by items selected by the facilitator. The facilitator should write the commodities that are chosen on handouts 4 and 5.

LMIS ACTIVITY

Gather all of the supplies listed below. It is recommended that the items be organized in five boxes, one box for each of five tables, before the session begins. Set up five stations in the room, each representing a laboratory facility. During a break, set these items on each table. You also will need an overhead projector for processing the activity.

Supplies required—

- Five envelopes
- Five 25-g containers of blue powder (blue Kool-Aid), labeled “Field stain A powder”
- Five 25-g containers of red powder (red Kool-Aid), labeled “Field stain B powder”
- Five 25-g containers of purple powder (purple Kool-Aid), labeled “crystal violet powder”
- Ten 500-mL storage bottles for reconstituted liquid Field stains with labels
- Five bottles of 20 buffer tablets (Alka-Seltzer tablets), labeled
- Five 100-g bottles of sodium azide powder (sugar), labeled
- Five gallons of water, labeled “distilled water”
- Five one-L storage bottles for buffered water, labeled
- Five boxes of sterile lancets (30 in each)
- Five bags of vacutainer needles (8 each)
- Five 500-mL bottles of 70 percent alcohol (use water), labeled
- Five boxes of capillary tubes (200 tubes each)
- Five packages of cotton balls (120 each)
- Five boxes of microscope slides (70 each)
- Five boxes of cover slips (160 each)
- Five 500-mL bottles of absolute methanol (use water), labeled
- Five bags of disposable plastic bulb pipettes, 5 mL (100 each)
- Five pencils
- Blank paper (have participants bring calculators, rulers, and pens)
- Five sets of 20 inventory control cards
- Five teaspoons, labeled
- Five boxes of gloves (50 pairs each)
- Five 500-mL measuring cylinders or cups
- Five 30-mL containers (for diluted Field stain B)
- Five plastic boxes, labeled “biohazard: infectious waste”

- Five plastic boxes, labeled “sink”
- Five transparencies and transparency markers (to be distributed at the beginning of Part 1 of Learning Activity III: LMIS Considerations for Laboratory Supplies).

CO-FACILITATORS

The co-facilitators should write on the flip charts, distribute the handouts, observe the simulation, and time the activities.

LEARNING ACTIVITIES SUMMARY

Title	Type	Time
Introduction	Session objectives and presentation	30 minutes
Key Laboratory Terms and Classifications	Discussion, activity, and exercise	45 minutes
LMIS Considerations for Laboratory Supplies	Simulation and discussion	180 minutes
National Laboratory Policies, Standardization, Forecasting and Quantification	Interactive discussion	90 minutes
Wrap-Up	Discussion	45 minutes

LEARNING ACTIVITIES

I. INTRODUCTION (30 MINUTES)

A. SESSION OBJECTIVES (10 MINUTES)

Brainstorm participants' expectations for the session. Write the responses on a flip chart.

Distribute handout 1: Laboratory Supply Logistics Session (goal and learning objectives).

Match expectations from the brainstorm activity with the goal and objectives on handout 1. Review any session objectives that were not raised in the brainstorm. On the flip chart, write any responses from the brainstorm that are not on the handout. If possible, try to work these areas into other sessions. Tell the participants that items that will not be addressed in the session can be discussed outside of class.

Explain to participants that the purpose of this session is NOT to be a laboratory services class; rather, the purpose is to use their current knowledge of logistics and apply it to laboratory services. The session will familiarize the participants with some laboratory commodities and the challenges in managing them.

Schedule

Refer the participants to the poster with the session schedule and indicate that we will try to follow the schedule closely. Remind participants that we will be starting and ending on time. We will have two 15-minute breaks, one in the morning and one in the afternoon. The times listed on the schedule may vary depending on the progress in the session. We will also have one hour for lunch.

Parking Lot

Show participants the parking lot poster; tell them that the parking lot will be used to track topics that don't pertain to the current topic but that will be addressed at a later time.

B. PRESENTATION (20 MINUTES)

> **Facilitator Note**: Use the PowerPoint slides and notes below for the activity in the session. Discuss each slide briefly and answer questions as they come up. Do not spend too much time on any one slide because it will probably be addressed in more detail later. Use the parking lot poster for lengthy questions or comments.

Show slide 1: Title Slide.

Introduce the session by telling participants that we are now going to apply what you have learned about logistics to the area of laboratory services.

Show slide 2: A Comprehensive HIV/AIDS Program (HIV/AIDs pyramid).

Note that laboratory services have largely been neglected in developing countries, but these services are essential to providing health care; they have received more attention recently because they are needed to support HIV/AIDS programs. More donors are now committing funding to laboratory services.

Facilitator Note: The participants will have attended the HIV/AIDS session, so be sure that they understand where laboratory services are found in the HIV/AIDS pyramid. "Laboratory infrastructure" is found on the outside of the pyramid as one of the pillars of a comprehensive HIV/AIDS program, but it is also within each level of the pyramid. Explain to the participants how labs are involved with each of these levels (examples below):

- Prevention: preventing mother-to-child transmission; HIV testing
- Detection: HIV testing; testing for sexually transmitted infections (STIs), opportunistic infections (OIs), and tuberculosis (TB)
- Treatment: testing for STIs, OIs, TB, and level of virus
- Palliative care: testing for STIs, OIs, TB, and level of virus; monitoring reaction to treatments
- Antiretrovirals (ARVs): monitoring response to antiretroviral therapy (ART) and detecting toxicity; baseline investigations.

Show slide 3: Purpose of Laboratory Services.

First, show the title of the slide. Ask participants: **Why are laboratory services considered important for HIV/AIDS programs?**

After answering a few questions, explain that for HIV/AIDS programs, there are three general reasons laboratory services are important (click to complete the slide):

Laboratory services support expanding ART services by—

- Diagnosing HIV, STIs, TB, and OIs
- Completing baseline laboratory investigations (complete blood count [CBC], liver function, kidney function, CD4 count, clinical chemistry, etc.)
- Monitoring response to ART and detecting toxicity.

Stress that lab services are not only important for HIV/AIDS programs but also that all health services depend on lab services. Explain that there are usually limited lab services available in health centers—simple procedures such as checking for malaria parasites in a blood smear—and that almost all hospitals offer a range of laboratory testing. Usually a country will also have one or more specialized laboratories at the central level that offer the more sophisticated tests.

Now, ask the participants to identify some of the commodities they think would be needed in a lab to provide adequate lab support services: **What commodities do you think of when we say laboratory supplies?** Tell the participants to think first about HIV/AIDS programs and then about general lab support. List all the commodities mentioned on a flip chart. Be sure to lead participants to name some durables such as glassware and microscopes.

Ask the participants to look at the list they have generated and to notice what seem to be different types or categories of products. (To prompt, compare some of the participants' answers: Are chemicals and test tubes similar or different? Are slides and test tubes similar or different? and so forth.) Ask: **How do you think we can classify these commodities to make them more manageable?** Lead the participants to classify these commodities into reagents, consumables, and durables. Make the point that these groups or classifications are practical for supply chain management and are NOT globally recognized terms.

Be sure the participants fully understand these three classifications. The short definitions are listed below and will be included in the glossary distributed later.

- Reagents are the chemicals used in laboratory testing for detecting or measuring an analyte.
- Consumables are items that are used once while performing a test and are not reused.
- Durables are items that can be reused for multiple tests.

Ask if the participants have any comments or questions. Tell the participants that they will get additional practice with the variety of commodities and their classifications throughout the session, and they will try to identify logistics considerations that are particular to each of the categories.

Show slide 4: Commodity Considerations (malaria test question).

Ask participants how many commodities they think are needed to do a simple blood smear test for malaria using one of the most common techniques. Take a few answers before showing the next slide. Write answers on a flip chart, as necessary.

Show slide 5: Commodity Considerations (malaria test answer).

Explain that nine different commodities are needed to do this test: five reagents and at least four consumables (and distilled water).

Facilitator Note: Do not spend a lot of time on the commodities; they are listed on handout 2. However, if asked, they are—

Reagents	Consumables
Field stain A	Blood lancet
Field stain B	Microscope slide
Methanol	Heparinized capillary tubes
Sodium azide	Microscope cover slips
Buffer tablets	

Ask the participants how many different ways you can test for malaria. Take a few answers and explain that there are at least four techniques for malaria testing:

- Field stain
- Giemsa stain
- Flow cytometry
- Rapid test.

Show slide 6: Commodity Considerations (number of tests at facilities question).

Ask participants how many different types of tests they think are performed at different levels of facilities. Take a few answers for each level of facility before showing the next slide. Write answers on a flip chart, as necessary.

Show slide 7: Commodity Considerations (number of tests at facilities answer).

The slide shows that from an example in a developing country, there may be 19 or more tests done in health centers, at least 26 in district level facilities, and 43 at regional level hospitals.

Remind participants that we said it takes nine commodities to do one malaria test; if you are doing 43 different tests and each might require nine commodities, then you could potentially need more than 350 commodities to provide the range of services in a regional lab. **While many of the tests may use the same commodities, the point is that labs need to manage a large number of commodities.**

Explain that this is the list of all tests that are relevant to HIV/AIDS. The list of tests needed to support HIV/AIDS programs as defined by the World Health Organization and the Centers for Disease Control and Prevention is very vague and can include more than 50 tests.

Distribute handout 2: Country Example of Basic Package Essential Laboratory Tests: Reagents and Consumables.

Distribute handout 3: Country Example of Test Menu and Technique by Level.

Explain that these are only examples of the commodities that are needed to do the tests and the types of tests that a lab might offer. The standards will change for different countries.

Point out the second column on handout 3, labeled *Standard Technique*. Refer back to the discussion on slide 5 about the different ways to do a malaria test. Explain that there are several tests that can be done using different techniques and that each technique can require different commodities. This adds to the number of commodities needed and the complexity of ensuring adequate supplies of those commodities. This will be discussed later.

C. SECTION SUMMARY

Remind participants that we just looked at—

- How laboratory services are part of every health service provided by a facility
- How quantities of commodities needed vary according to the type of test
- The types and number of tests that a facility conducts according to its level in the health care system.

Ask participants if they have any questions.

II. KEY LABORATORY TERMS AND CLASSIFICATIONS (45 MINUTES)

A. LABORATORY COMMODITY CLASSIFICATION EXERCISE

Tell the participants that we are now going to do a short exercise to identify and classify some laboratory commodities. Explain to them that there are three stations set up in the room and that each station has the **same 10 laboratory commodities.** Show the participants the stations (these should already be set up as described earlier in the facilitator's preparation section, "Laboratory Commodity Classification Activity"). Divide the participants into three groups and assign each group a station.

Distribute handout 4: Laboratory Commodity Classification Quiz.

Ask the participants to write their answers in the blank spaces on the form. Tell them that **they have five minutes** to look at each of these items and decide which of the three classifications each item falls into: reagent, consumable, or durable. Remind participants that the poster with the classification definitions is on the wall.

After five minutes, invite the participants to sit down. Begin to process the exercise by asking them: **Did any of the items look familiar? Did you have a difficult time classifying any of these items?** After taking a few answers, go through each item and ask participants to classify it. When there is disagreement, spend a little time on that item to discuss the classification. As you, the facilitator, process the exercises, organize the items at one station into the three classifications. Once you are done processing, tell the participants that the items will be left in the groups so they can review them during the break.

Distribute handout 5: Laboratory Commodity Classification Answer Sheet.

> **Facilitator Note**: The two remaining stations may be divided to allow for more space in the training room.

Explain to participants that now that we have looked at the classification of lab commodities and become familiar with some of the terms, the following handouts are reference materials for advisors on lab commodities and terms. After giving the handouts to the participants, allow at least a few minutes to read through them.

Distribute handout 6: Photo Glossary: Consumable and Durable Laboratory Supplies.

Explain to the participants that this glossary is for internal use only, to expose them to laboratory commodities that they may use in the field. This is an expanding list, so the participants should let the team know of additional items.

Distribute handout 7: Technical Terms and Definitions for Laboratory Logistics.

Tell the participants to use this glossary as a reference and to inform the lab team if any additional terms should be included.

Ask participants if they have any questions on handouts 6 and 7.

B. CLASSIFICATION QUIZ

It's quiz time! Tell participants that we will now have a quick quiz on some key laboratory terms.

Distribute handout 8: Key Laboratory Terms Quiz.

Ask the participants to match the terms with the definitions in this short quiz. **Give them five minutes to do this.** Mention that they can use handout 7, the glossary of laboratory terms, if they need it.

After five minutes, **distribute handout 9: Key Laboratory Terms Quiz Answer Sheet, and briefly review the answers.**

Ask the participants if they have any questions or comments. **Make sure the participants understand the difference between a technical standard operating procedure (SOP) and a logistics SOP:** a technical SOP describes how to **run a test**, and the logistics SOP describes how to **run the logistics system for laboratory supplies**.

C. SECTION SUMMARY

Remind participants that we have—

- Looked at how DELIVER has classified laboratory commodities, consumables, reagents, and durables.
- Sorted commodities according to their classification.

Tell the participants that for laboratory supplies, the term *usage* is used in place of *consumption* or *dispensed*. Ask the participants if anyone can explain why this is the case.

The correct answer is: ***Usage* is used instead of *consumption* or *dispensed* because the supplies are not being consumed by or dispensed to a patient but are being used to conduct a laboratory test.**

Ask participants if they have any questions on the classification of laboratory commodities.

III. LMIS CONSIDERATIONS FOR LABORATORY SUPPLIES (180 MINUTES)

A. DEVELOPING A LABORATORY LMIS

Tell the participants that we are now going to discuss some of the considerations for developing an LMIS for laboratory supplies.

Ask the participants if anyone can—

- Recite the three essential data items: consumption, stock on hand, and loss/adjustments.
- Name the three types of records with an example of each: consumption records (daily activity register), stockkeeping records (stock card), and transaction records (requisition and issue voucher).
- List the types of reports they reviewed during the LMIS session: summary reporting, report and request and feedback reports. Explain that these are also needed for a laboratory LMIS.

> **Facilitator Note**: If the participants need more review of records and reports, ask them to explain the difference between a record and a report and list the different information found on each form.

Distribute handout 10: Logistics Records and Reports: Types and Data.

Explain that this handout should look familiar; it is from the LMIS session. The participants should use this as a reference during the simulation.

B. SIMULATION FOR LABORATORY COMMODITIES

> **Facilitator Note**: Make sure the preparation for this activity is completed as described earlier in the facilitator's preparation section, "LMIS Activity." The laboratory supplies listed in the facilitator's preparation have been placed on all of the participants' tables during the break.

Setup of the Simulation

Tell the participants that we are going to do a simulation for lab commodities used for a malaria test. Split the participants into five groups of no more than five participants per group and assign each group a table. Make sure the participants are separated by knowledge level so that at least one "seasoned" logistics expert is at each table. After participants are settled at their tables, explain that this simulation has three parts:

Part 1 is the design of the LMIS forms.

Part 2 is the reconstitution of reagents.

Part 3 is the simulated test.

Tell them that they will receive instructions on each part of the simulation when it begins.

On their tables they have the supplies that will be used during the simulation.

Facilitator Note: The facilitator should show the participants each item and how it is to be used in the simulation.

Participant Expectation during the Simulation

Tell participants that they are expected to manage the laboratory commodities by applying the logistics principles they have learned so far and the lab-specific material that we have covered in this session.

Ask participants if they have any questions. After questions have been answered, tell them that we are now ready to start the simulation.

Part 1

Distribute handout 11A and B: Part 1: Introduction.

Tables 1, 3, and 5 will get handout 11A, and tables 2 and 4 will get handout 11B. Give the participants a few minutes to read the handout and ask if anyone has any questions. Remind the participants that they will need to capture the **three essential data items** for all of these commodities. Advise the participants that they may have to **allocate responsibilities** to different people within the group. Explain that in each envelope there are stock cards and blank paper for them to develop the other required LMIS forms.

Give the participants 20 minutes to organize their stock and decide on LMIS forms. Walk around and make sure that the participants understand how to develop the forms. If needed, explain that, for this exercise, these forms should focus on the actual design and that participants should not get caught up in the details (such as facility type and signatures). When completed, ask each group to put one of the forms on a transparency: two groups put a consumption record, one group puts a stock card, and two groups put the monthly report.

Facilitator Note: The participants will not use the crystal violet stain or the vacutainer needles for the test they will be running.

Announce when the 20 minutes are finished. Ask if any group had difficulties with this portion of the activity. If so, quickly discuss what the problem was and any recommendations. Ask them if they were able to develop forms that will provide the three essential data items for reporting. Do not move on until all of the groups are confident about their LMIS forms. Tell the participants to put aside their transparencies. They will not need them until processing.

Part 2

Distribute handout 12A and B: Part 2: Reconstitution.

Tables 1, 3, and 5 will get handout 12A, and tables 2 and 4 will get handout 12B. Give the participants a few minutes to read over the sheet. Make sure that they understand that the measurements will not be exact but should be a best guess. **Tell the participants that they have 10 minutes for this part.**

After 10 minutes, ask if everyone has finished. If any of the groups are taking too long, remind them that they do not need to be exact.

Part 3

When all groups are done, **distribute handout 13A and 13B: Part 3: One Month at the Laboratory.**

Tables 1, 3, and 5 will get handout 13A, and tables 2 and 4 will get handout 13B. Tell the participants that this is where the action begins. **They will have 30 minutes to perform the tests requested, following the SOPs and recording the logistics data required.** They will receive a 5-minute warning before the time is up and should make sure to have a report ready by the end of 30 minutes. Make sure that the participants realize that they are **NOT TO ACTUALLY PERFORM** the test; instead, they are to put the used supplies in the appropriate containers when they are **considered** used for a test.

> **Facilitator Note**: The following are possible interventions that may be used if everything is going well. Before using any of these, you should make sure that participants understand the simulation concept and how it is supposed to work before you throw them any curve balls.
>
> - Pour some of the stock reagent into the waste container and say there was some wastage due to a spill.
> - Pour all of one stock reagent into the waste container and say it was left in the sunlight or was not capped in the evening and is no longer usable. Tell them they will have to reconstitute another bottle.
> - Remove some consumables and say that they were dropped on the floor and are no longer usable.

Facilitators should walk around and take note of some of the issues that arise. The processor should be aware of these issues. If at any time during this simulation it appears that there are many questions, stop the action and make sure that everyone understands the process. Give the participants a warning at five minutes before the end that they should make sure to have some logistics data ready.

Processing the Simulation

> **Facilitator Note**: The processing of the simulation should be done by parts. However, first ask some general questions and then proceed to the different parts of the simulation. Conclude by talking of the simulation as a whole. There are some sample processing questions below that can be used to start the discussions.

Stop the action at the end of 30 minutes. Ask the participants to take the transparency LMIS form and write the data required on that form. Tell them that they will present their transparencies to the whole group. However, let's start the simulation processing by addressing the following questions.

Sample processing questions

General questions—

- How do you feel?
- What do you believe went well?
- What do you believe could have been done differently?

Ask the participants to identify any challenges that they faced during the simulation: **what made your work challenging or difficult?**

Write the list of challenges on a flip chart. Once the list is final, go back through the list and ask how many groups faced the same challenge and how they worked to address the challenge or resolve the problem.

Once the challenges have been addressed, start to turn the participants' attention to the principle of standardization (in preparation for the next activity and discussion). Ask the participants: **What kind of guidance was given to your group? Did it make your job easier or more difficult? How would your job have been more difficult if you had NOT been given the guidance you were given? Do you suppose that all countries provide the guidance that you were given for this activity?**

Aside from the specific guidance that was given, is there anything else you can identify that made your job easier?

Then ask: **what additional guidance would have made your job easier?** Possibilities to explore are listed below. (The specific points to discuss are at the discretion of the facilitator, based on the discussions that have already taken place during the session and what happened during the simulation. Other points can be added as well.

- Look at how each group arranged its products. Would it have helped to have guidance in that area?
- How did you divide up the work on your teams? Would it have helped to have guidance in that area?
- How many forms did each team end up using? Would it have helped to have guidance in that area?
- What were the units of measure you used on your various forms? (Ask specifically about different categories of product that would lend themselves to differences, e.g., reagent powder vs. capillary tubes.) Would it have helped to have guidance in that area?
- How many "levels" did you have in your lab? One level? Two levels with an intermediate point for reconstitution and issuing to the lab technician? Would it have helped to have guidance in that area?
- How did you use the daily activity register? Would it have helped to have guidance in that area?
- Did you change the way you were doing things as you went along (i.e., learning from your experience to facilitate the work or make it easier or less complicated)?

As a summary of the discussion so far, ask several of the participants to explain the technique they used to test for malaria. Congratulate the participants, noting that they are now able to use a variety of technical terms with ease.

Discussion of participants' LMISs

Tell the participants that we will focus for a few minutes on their LMISs. Ask the participants to identify which forms, records, and reports they used to manage their facility. At a minimum, the participants should identify the stock card and the monthly report; the daily activity register will probably also be mentioned.

Show the overheads of several of the forms that the participants developed. Ask the participants to summarize their forms—namely, the contents and how the form is used. Briefly discuss any issues with the forms and address any participant questions.

Ask the participants: **Do you have any suggestions for how to make a successful laboratory LMIS? How would you recommend adapting an LMIS to manage lab supplies? Brainstorm these ideas on a flip chart.** Take about 10 minutes to do this activity.

Suggested recommendations include—

- Tracking usage from the inventory as issues, not from the bench; for example, when the reagent powder is taken from the larger stock to be reconstituted, it is considered used. When consumables such as slides are taken from inventory to the bench, they are considered used.
- Tracking a few *high ticket* tracer items, such as CD4 reagent test kits, on a test by test basis. These items are supplies that are expensive, easily diverted to the illegal market or private practice, or politically important.
- Computerizing the system at the central level so the laboratory personnel do not need to be burdened with determining the reorder requirements according to logistics principles.

Distribute handout 14: Considerations and Recommendations for a Laboratory Logistics Management System.

Explain that these are some key considerations and recommendations with regard to a laboratory LMIS from DELIVER's experience.

C. SESSION SUMMARY

Summarize this session by telling participants that they just did a simulation in which they had to design forms, prepare reagents, conduct a test, and report on the three essential data items. The simulation focused on only one test, but it gave them a better understanding of the complexity of working with laboratory supply logistics. Tell the participants that the purpose of this exercise was not necessarily to focus on the development of an LMIS but to understand the challenges of accounting for lab supplies compared to other commodities that they may have seen or worked with.

Ask participants if they have any questions.

IV. NATIONAL LABORATORY POLICIES, STANDARDIZATION, AND FORECASTING AND QUANTIFICATION (90 MINUTES)

Tell participants that we are now going to discuss national laboratory policies, standardization, and forecasting and quantification. Let's start by looking at national laboratory policies.

A. NATIONAL LABORATORY POLICIES

Ask the participants to list the types of activities that JSI/DELIVER is involved with in the field. If answers come slowly, ask the participants what activities *they* have been involved with in the field. Write the activities on a flip chart. **Be sure to list at least assessment, system design, and quantification.** Point out to participants that, though all the activities mentioned are important for a supply chain logistics system, for the purpose of this workshop we will work with only three activities. Highlight these three activities on the flip chart:

1. Assessment
2. System design
3. Quantification.

Explain that each of these activities depends on defined policies to lay the groundwork for all laboratory work in the country. **The national policy guidelines are the overarching structure of the laboratory system in a country and define the regulatory setting for laboratories.**

Show slide 8: Required Laboratory Policies.

Go through each of the policies and explain what activities may be affected by each policy.

> **Facilitator Note**: Each of these policies affects each of the logistics activities. For example, to conduct an assessment you need to know what the administrative structure is, the test menus that should be offered at each lab by level, the staff that should be at each level and their responsibilities, who should be offering and receiving supervision, what the defined QA/QC scheme(s) are, if there is a patient referral system, and whether there are SOPs by level. These criteria will be used to assess the labs.

Ask the participants if they have any questions or additions. Explain that without these policies it is very difficult to conduct any of the activities mentioned above.

B. STANDARDIZATION

Tell the participants that we will now look at standardization. Ask the participants—

- What do you think standardization is?
- What does it mean?
- What is standardized?

Take some answers, and then tell the participants that to understand this concept we are going to use an example of car maintenance.

1. Ask those participants who own a car to raise their hands.

2. Ask a few of the car owners what kind of car they have.

Facilitator Note: Try to get a variety of foreign cars (e.g., Honda, VW, BMW, Nissan, Toyota, Mazda) and American cars (e.g., Ford, Chevrolet, Chrysler, Dodge).

3. Ask the participants if they think the items needed to do a tune-up for all of these cars are the same. Can one use the same brand of air filter for a BMW and a Ford? What about the spark plugs?

Facilitator Note: Items typically required include spark plugs, spark plug wires (ignition wire set), distributor cap, distributor rotor, oxygen sensor, oil filter, air filter, PCV (positive crankcase ventilation) breather filter, fuel filter, transmission filter, vacuum hoses, temperature sensors, lubricants, coolant hoses, belts, and so on.

Describe to the participants the following scenario:

Pretend Joel Lamstein wants to buy the parts to provide a tune-up for every car owner at JSI, but he wants to buy only 15 items in bulk. **Which items should he buy? Should he buy items for the car model that the majority of the JSI staff owns? What about the other car owners? Can they use these 15 items?**

Tell participants that this decision is what many Ministries of Health face when trying to decide which laboratory supplies to procure because different labs are using different techniques for the same test. These different techniques require different commodities.

Therefore, the supplies procured for a malaria smear using the Field staining technique will not help those who are using the Giemsa staining technique, just as the parts to do a tune-up for one person's BMW will not help someone with a Ford.

What is helpful and necessary in many developing countries is standardization so that labs at the same level (e.g., a district level laboratory) are using the same technique for the same test. What do we mean when we are talking about standardization?

Show slide 9: Laboratory Standardization.

Explain to the participants that standardization with regard to the laboratory means—

- Set test menus by level (which tests will be conducted at which level)
- Set test techniques by level (there are often multiple techniques that can be used to conduct each test, such as in the malaria example)
- Defined technical SOPs by level (not to be confused with logistics SOPs) that instruct staff on how to conduct each test.
- Agreed instrumentation by level (this may be addressed when standardizing techniques).

Explain to the participants that there are many challenges to standardization in resource-limited settings:

- The training schools sometimes teach different techniques for the test than are specified in the SOPs.
- Each laboratory practitioner has a preferred technique for conducting a test. Sometimes gaining consensus on the best technique for a test is difficult.
- Without continuous supply of commodities to support the defined SOPs, the lab personnel will use supplies for whichever technique is available.

C. FORECASTING AND QUANTIFICATION

Tell the participants that we are going to take a closer look at forecasting and quantification. Ask them: **What is the challenge of forecasting supply needs in a nonstandardized laboratory system?**

Answers should include—

- The large number of supplies.
- Inability to forecast by level because each lab is doing different techniques requiring different supplies and using different amounts per test. This means extensive work for the forecaster, who will have to look at each test (could be more than 50) at each laboratory (could be more than 500 in the country).
- Creating a new standard because there is no existing standard. The accuracy of the forecast results could be questionable if the staff are not trained in using the new standards and SOPs.
- The need to procure specific test combinations (based on SOPs) to be received at the same time. You cannot run the test if you have only eight of the nine items required.
- The requirement that equipment being procured must be standardized. Often the equipment that is functional and used is not standardized. This means that not all of the SOPs will be the same; therefore, the supplies and quantities of supplies will be different depending on the equipment.
- The requirement for different commodities every time there is a different test technique.

Let's look at an example of a hemoglobin test that has approximately eight manual techniques.

Distribute handout 15: Manual Hemoglobin Tests and Laboratory Supplies Needed.

Point out to the participants that if the labs in one system were to use all eight techniques, they would need 9 reagents, 14 consumables, and 22 durables.

Some processing questions—

- What are the implications for the supply chain of multiple techniques for many different tests (up to 50 tests can be considered HIV related)?
- What are the implications for forecasting and quantification if there are no standardized SOPs?
- What does this mean for quality?

> **Facilitator Note**: You cannot compare the results from a hemoglobin test using the Sahli method versus the HemoCue. Tests cannot be reproduced to check for quality between labs (benchmarking lab results).

Explain that handouts 2 and 3 show additional commodities needed for specific techniques and a more detailed test menu.

Tell the participants that the *Guide for Forecasting and Quantification of Laboratory Commodities* is available on the DELIVER website/the new Guidelines for Managing HIV/AIDS

Supply Chain CD. This document will provide more details on the processes for quantifying for lab supplies.

D. SESSION SUMMARY

Recap by telling participants that during this session we looked at—

- How national policies affect the activities of a laboratory
- The importance of standardization for laboratory logistics
- The challenges in forecasting and quantification for laboratory logistics.

Ask participants if they have any questions on the material just covered.

V. WRAP-UP (45 MINUTES)

Facilitator Note: Display the flip chart with the objectives before the session begins. The facilitator should write the participants' answers on the flip chart.

REVIEW EXERCISE

Tell the participants that a lot of information has been covered today about the five learning objectives. We will now look at each of the objectives and summarize three key points (challenges and recommendations, if applicable) for each one.

The topics are—

- Key laboratory terms and classifications
- LMIS considerations for laboratory supplies
- National laboratory policies
- Operating procedure standardization
- Forecasting and quantification.

Select the topic to start with. Ask participants what they believe are key points to remember for this topic. If some key points are missing in their answers, be sure to review those. Repeat this process for each topic.

KEY LABORATORY TERMS AND CLASSIFICATIONS

- Lab supplies, for the purpose of logistics, can be classified into three groups: reagents, consumables, and durables.
- Closed systems are laboratory instruments that require a specific brand of reagents, and open systems are laboratory instruments that do not require a specific brand of reagents.
- Both open and closed systems have an impact on the supply chain; if there are different closed systems, they will require different commodities. Also, the commodities associated with a closed system will likely be more expensive but may possibly have higher quality (because the tests are linked to one supplier).
- Standardization is the development and implementation by level of set test menus, set test techniques, defined SOPs, and agreed instrumentation of a laboratory system.
- SOPs define how to perform a test, including the commodities and amounts required per test.
- QA/QC schemes manage the quality of all aspects of the laboratory testing process. This is an important logistics concept; the additional commodity requirements need to be included in a lab supply forecast.

LMIS CONSIDERATIONS FOR LABORATORY SUPPLIES

- Maintaining an LMIS for one test was time- and labor-intensive. Doing this for 200 supplies may be overwhelming for laboratory staff.

- Tracking daily usage of laboratory supplies is also very time-consuming and requires a lot of detail and math. The actual figures will be inaccurate because of the assumptions that must be made along the way of how much powder will be used during a test when the powder is reconstituted as a liquid. Tracking usage from the inventory as issues is a possible recommendation.
- Tracing, if possible, a few *high ticket* items, such as CD4 reagent test kits, on a daily basis is important. These items are supplies that are expensive, easily diverted to the illegal market or private practice, or politically important.
- Computerizing the system at the central level is recommended so that laboratory personnel do not need to be burdened with determining reorder requirements according to logistics principles.

NATIONAL LABORATORY POLICIES

- National policies affect almost every activity that involves logistics advisors, particularly with regard to assessment, system design, and quantification.
- National policies should include laboratory administrative structure, test menus by level, staffing responsibilities and training by level, supervisory roles, QA/QC schemes, and specimen/patient referral systems.

OPERATING PROCEDURE STANDARDIZATION

- Standardization in the context of the laboratory means set test menus by level, set test techniques by level, defined SOPs by level, and agreed instrumentation by level. Standardization simplifies the supply chain, is required if an external QC system is used, is important to ensure internal quality (the same SOP being used by all staff in a lab), and makes forecasting manageable when using test numbers.

FORECASTING AND QUANTIFICATION

- Standardization by level is highly recommended to develop an accurate forecast.
- Forecasting by level is very difficult if each lab is doing different techniques requiring different supplies and using different amounts per test; this means extensive work for the forecaster, who will have to look at each test (could be more than 50) at each laboratory (could be more than 500 in the country).
- In creating a standard because there is no existing standard, the accuracy of the forecast results could be questionable if the staff are not trained in the new standards and SOPs.
- Procuring a specific test combination (based on protocol) must be planned in advance so that all items are received at the same time.
- The equipment being procured must be standardized. Often, the equipment that is functional and used is not standardized. This means that not all of the SOPs will be the same; therefore, the supplies and quantities of supplies will be different depending on the equipment.

REVIEW OF THE FIVE OBJECTIVES

Review each of the five learning objectives with the participants. Ask them if they feel that all of the objectives were met.

PARKING LOT

If there are any outstanding questions on the parking lot, take time to address them now or tell the participants that the team will try to answer the questions and will email all of the participants.

Conclude by explaining to the participants that this session has planted the seed for more detailed discussion on laboratory supply logistics. The lab team is available for more detailed discussions.

Ask participants if they have any questions on the material that we covered today.

COURSE EVALUATION

As the final activity in the workshop, ask the participants to complete an evaluation form. Let them know that we will use the information provided to improve this workshop. Tell participants to leave their evaluations in the envelope at the front of the room.

Thank the participants for their attendance today.

You are done. (Don't forget to clean up!)

> **Facilitator Note**: If time permits and the right people are in the room, the following advocacy discussion should take place. The lead facilitator should determine if this session is held.

ADVOCACY DISCUSSION

Explain to the participants that no programs (HIV/AIDS, malaria, TB, even some family planning programs) can stand without laboratory programs. The labs are typically the LEAST DEVELOPED area in health services, and this needs to be addressed to have successful health programs.

The facilitators should discuss with the participants the activities that DELIVER has been doing in laboratory supply logistics and what DELIVER is capable of doing. They should review the logistics cycle to explain that DELIVER now has experience in each of the following areas:

- assessment
- LMIS development and roll-out
- inventory control system development and roll-out
- forecasting and quantification
- procurement
- policy review and adjustment.

HANDOUT 1

LABORATORY SUPPLY LOGISTICS SESSION

GOAL

Introduce participants to issues related to supply chain management in support of essential laboratory services.

LEARNING OBJECTIVES

By the end of the session, participants will be able to—

1. Define common terms used in laboratory services and identify and describe the different classifications for commodities used in laboratory services.
2. Describe the key points that should be in a national policy document that applies to the management of laboratory supplies (including the concept of test menus and test techniques by level, quality assurance/quality control schemes, and the regulatory framework for laboratory services) and the implications the policies have on supply chain management.
3. Describe the importance of standardization of operating procedures for laboratory logistics.
4. Describe similarities and differences in a logistics management information system (LMIS) for laboratory supply management as compared to an LMIS for other health commodities.
5. Identify challenges in forecasting and quantifying needs for laboratory supplies and factors to take into account when doing these activities.

HANDOUT 2

COUNTRY EXAMPLE OF BASIC-PACKAGE ESSENTIAL LABORATORY TESTS: REAGENTS AND CONSUMABLES

Table 1. Blood Smear for Hemoparasites: Malaria + Others

Reagents	Consumables
Field stain A	Blood lancets, fixed point
Field stain B	Microscope slides (single frosted, pre-cleaned)
Methanol, absolute 99.9%	Heparinized capillary tubes, glass, 1.5–1.6 mm x 75 mm
Buffer tablets, pH 7.2	Cover slips 22 × 22 mm
Sodium azide	

Table 2. Hemoglobin Estimation: Comparator Method

Reagents	Consumables
Hydrochloric acid	Test tubes, borosilicate glass, 100 × 16 mm
Ammonia solution	

Table 3. Stool Microscopy

Reagents	Consumables
Sodium chloride	Microscope slides (single frosted, pre-cleaned)
Iodine resublimed	Microscope cover slips
Potassium iodide	Gauze mesh
Formaldehyde	Applicator sticks
Ether	Stool containers, 28 mL, screw cap, labelled, with spoon
Teepol	Centrifuge tubes, ungraduated, borosilicate glass

Table 4. Sputum Microscopy for AFB (Acid-Fast Bacillus) Smears and Cultures (Tuberculosis)

Reagents	Consumables
Basic (carbol) fuchsin	Microscope slides (single frosted, pre-cleaned)
Methanol, absolute 99.9%	Plastic sputum containers, 28 mL, screw cap, wide mouth, labeled
Sulphuric acid	
Methylene blue	
Phenol detached crystals	
Ethanol	

Table 5. Urinalysis

Reagents	Consumables
Urine test strips, two parameters (protein + glucose)	Universal containers, glass, 28 mL
	Microscope slides (single frosted, pre-cleaned)

Table 6. Urine Microscopy

Reagents	Consumables
	Universal containers, glass, 28 mL
	Centrifuge tubes, ungraduated, borosilicate glass
	Microscope slides (single frosted, pre-cleaned)
	Microscope cover slips 22 × 22 mm

Table 7. Syphilis Screening

Reagents	Consumables
RPR (rapid plasma reagin) carbon antigen test kit—(rapid test kits)	Vacutainers, plain EDTA (ethylenediaminetetraacetic acid), sterile, 10 mL
	Vacutainer needles, 21G
	Vacutainer needle holder
	Blood lancets
	Heparinized capillary tubes, glass/plastic
	Needles 21G + syringes 5 mL

Table 8. General Microbiology: Gram Stain, Wet Preparation, etc.

Reagents	Consumables
Crystal violet	Microscope slides (single frosted, pre-cleaned)
Ethanol 95%	Microscope cover slips 22 × 22 mm
Ammonium oxalate	Bijou bottles, screw cap, sterile, labeled
Iodine resublimed	Sterile swabs, in plastic tube
Potassium iodide	
Acetone 99%	
Safranin O, neutral red	
Sodium chloride	
Transport medium (Stuart's/Cary-Blair)	
KOH (potassium hydroxide)	

Table 9. HIV Screening Test

Reagents	Consumables
HIV rapid test kits (Determine, UniGold + tie-breaker kit)	Blood lancets
Chase buffer for Determine	Heparinized capillary tubes, glass/plastic
	Vacutainers, plain, sterile 10 mL
	Vacutainers, EDTA, sterile 10 mL
	Vacutainer needles, 21G
	Vacutainer needle holder

Table 10. White Blood Cell Count (Total/Differential)

Reagents	Consumables
Methanol, absolute, 99.9%	Blood lancets
Buffer tablets, pH 6.8	Heparinized capillary tubes, glass/plastic
Acetic acid, glacial	Vacutainers, EDTA, sterile, 6 mL
Leishman stain	Vacutainer needles, 21G
	Vacutainer needle holder
	Khan tubes, 12 × 75 mm, glass
	Microscope slides (single frosted, pre-cleaned)
	Microscope cover slips

Table 11. Cerebral Spinal Fluid (CSF) Microscopy

Reagents	Consumables
India ink, biological stain	Bijou bottles, screw cap, sterile, labeled
Crystal violet	Microscope slides (single frosted, pre-cleaned)
Ethanol 95%	Microscope cover slips
Ammonium oxalate	
Iodine resublimed	
Potassium iodide	
Acetone 99%	
Safranin O, neutral red	

Table 12. Cerebral Spinal Fluid (CSF) Chemistry

Reagents	Consumables
Protein standard kit (Proteonometer)	Bijou bottles, screw cap, sterile, labeled
Glucose oxidase kit (Randox/Human)	Test tubes, 75 × 12 mm, borosilicate glass
Sulphosalysilic acid	Vacutainers with sodium fluoride tubes

Table 13. Pregnancy Test

Reagents	Consumables
Pregnancy test kit (latex test)	Universal containers, glass, 28 mL

Table 14. Blood Grouping and Compatibility

Anti A	Test tubes, 75 x 12 mm glass
Anti B	Grouping tiles
Anti AB	Pasteur pipettes, plastic 3 mL
Anti D	Applicator sticks
AHG (antihuman globulin)	Vacutainer tubes, plain
Sodium chloride	
Albumin 2090	

Table 15. General Requirements

Reagents	Consumables
Immersion oil, tropical grade	Lens tissue
Xylene	Filter papers, 15 cm, Whatman No. 1
Sodium hypochlorite 3.5%, 5 L	Universal pH paper, pH 5–14, roll
Methylated spirit	Cotton wool, absorbent, HQ (hospital quality), 500 g roll
Lysol	Latex examination gloves, disposable –medium size –large size
Liquid soap	Neubauer counting chambers + spare cover slips
	Microscope slide blotting paper
	Plastic Pasteur pipettes, 3 mL, graduated
	Nichrome wire, 1-mm diameter, wire loop holder
	Disposable face mask
	Filter papers, round, Whatman No. 1, 32 cm
	Universal containers, glass, 28 mL
	Preprinted labels (name, age, sex, hospital, patient number, ward, date)
	Fuchs Rosenthal counting chambers + spare cover slips
	Freestanding cryo vials, screw cap, 2 mL

HANDOUT 3

COUNTRY EXAMPLE OF TEST MENU AND TECHNIQUE BY LEVEL

Tests Performed at Health Center Laboratory	
Laboratory Test	**Standard Technique**
❑ Hemoglobin estimation	❑ Oxyhemoglobin, Lovibond comparator ❑ Cyanmethemoglobin, Sahli
❑ Blood slide for hemoparasites	❑ Field stain
❑ Stool microscopy for parasites	❑ Direct saline, iodine
❑ Sputum for AFB	❑ ZN stain
❑ Skin slit for AFB	❑ ZN stain
❑ Urine sediment microscopy	❑ Direct microscopy
❑ Urine protein, sugar	❑ Uristix
❑ Syphilis screening	❑ RPR/VDRL carbon antigen
❑ Sickle cell screen	❑ Sodium metabisulphite
❑ Genitourinary tract specimens	❑ Wet prep/Gram stain/KOH
❑ Pus swabs	❑ Gram stain
❑ Bubo aspirate (plague)	❑ Wayson staining
❑ HIV screening	❑ Rapid screening kits
❑ Blood grouping	❑ Tube method
❑ Rhesus typing	❑ Tube
❑ Total white cell count ❑ Total red cell count	❑ Manual, hemocytometer using Turk's fluid
❑ Differential white cell count	❑ Manual, using stained thin film
❑ Cerebrospinal fluid microscopy	❑ Gram/Leishman/Turk's fluid
❑ Cerebrospinal fluid chemistry	❑ Turbidimetric
Additional Tests Performed at District Hospital Laboratory	
❑ Concentration technique ❑ Blood ❑ Stool	❑ Buffy coat (Knotts) ❑ Formal ether
❑ Urine qualitative chemistry (protein, sugar, ketones, blood bilirubin, urobilinogen)	❑ Multistix or equivalent
❑ Skin snip for microfilaria	❑ Saline direct
❑ Collection and fixation of cytological smears	❑ Formalin
❑ Collection and fixation of histological specimens	❑ Formalin

Tests Performed at Regional Hospital Laboratory (continued)	
❑ Hemoglobin estimation	❑ Hematology analyzer
❑ Total white cell count	
❑ Total red cell count	
❑ Differential blood counts	
❑ Platelet count	
❑ Reticulocyte count	
❑ Blood indices	
❑ CD4/CD8 count	❑ Flow cytometer ❑ Non-cytofluorimetric ❑ Manual
❑ Viral load	❑ HIV RNA ❑ Real-time PCR ❑ Heat-dissociated p24 antigen ❑ Cavidi RT
❑ Sickle cell screening test	❑ Sodium metabisulphite
❑ Blood slide examination for parasites	❑ Manual microscopy (field) ❑ Concentration
❑ Film comment	❑ Manual microscopy (Romanosky)
❑ Stool microscopy	❑ Direct saline/iodine concentration
❑ HIV screening	❑ Rapid screening kits
❑ Hb types	❑ Electrophoresis
❑ Serum proteins	❑ Electrophoresis
❑ Hepatitis B screening	❑ Rapid ELISA
❑ Syphilis screening	❑ RPR/VDRL carbon antigen
❑ Serum bilirubin	❑ Chemistry auto-analyzer (or manual photometer)
❑ SGOT (serum)	
❑ SGPT (serum)	
❑ Alkaline phosphatase (serum)	
❑ Renal function tests	
❑ Blood glucose	❑ Chemistry auto-analyzer (or manual photometer)
❑ Serum electrolytes	
❑ Total protein	
❑ Examination of CSF for yeast	❑ Negative staining (India ink)
❑ Examination of CSF, pus, deposit, etc., microorganisms	❑ Gram stain
❑ Culture	❑ Aerobic ❑ Anaerobic ❑ CO2
❑ Drug sensitivity	❑ Disc diffusion
❑ Microscopy for plague	❑ Wayson staining
❑ Processing biopsy	❑ Hematoxylin and eosin
❑ Semen analysis	❑ Microscopy
❑ Cytology	❑ Microscopy ❑ Pulp smear

Tests Performed at Regional Hospital Laboratory (continued)	
❑ Sputum for TB	❑ ZN stain
❑ Urine sediment microscopy	❑ Direct microscopy
❑ Urine chemistry	❑ Multistix or equivalent
❑ Genitourinary track specimens	❑ Wet prep ❑ Gram ❑ KOH
❑ Blood group, type, and cross matching	❑ Tube method
❑ Skin snip for microfilaria	❑ Saline direct
❑ Examination for fungi	❑ KOH
❑ Confirmatory test for syphilis	❑ TPHA

Note: AFB = acid-fast bacillus; ZN = Ziehl-Neelsen; RPR = rapid plasma reagin; VDRL = venereal disease research laboratory; KOH = potassium hydroxide; RNA = ribonucleic acid; PCR = polymerase chain reaction; RT = reverse transcriptase; Hb = hemoglobin; ELISA = enzyme linked immunosorbent assay; SGOT = serum glutamic oxolocetic transaminase; SGPT = serum glutamic pyruvic transaminase; CSF = cerebrospinal fluid; CO2 = carbon dioxide; TB = tuberculosis; TPHA = Treponema pallidum haemagglutination assay.

HANDOUT 4

LABORATORY COMMODITY CLASSIFICATION QUIZ

Write the name of the classification that best describes the commodity: reagent, consumable, or durable.

Laboratory Commodity	Classification
1. lancet	
2. Field stain A powder	
3. vacutainer holder	
4. microscope	
5. Field stain B powder	
6. microscope slide	
7. buffer tablets	
8. serological pipette	
9. vacutainer needle	
10. Sahli hemoglobinometer	

HANDOUT 5

LABORATORY COMMODITY CLASSIFICATION ANSWER SHEET

Laboratory Commodity	Classification
1. lancet	consumable
2. Field stain A powder	reagent
3. vacutainer holder	consumable
4. microscope	durable
5. Field stain B powder	reagent
6. microscope slide	consumable
7. buffer tablets	reagent
8. serological pipette	durable
9. vacutainer needle	consumable
10. Sahli hemoglobinometer	durable

HANDOUT 6

PHOTO GLOSSARY: CONSUMABLE AND DURABLE LABORATORY SUPPLIES

To find this document, go to Additional Laboratory Resources on the CD entitled Resources for Managing the Laboratory Supply Chain, or go to the DELIVER website at http://www.deliver.jsi.com.

HANDOUT 7

TECHNICAL TERMS AND DEFINITIONS FOR LABORATORY LOGISTICS

analyte
An analyte is the substance that is being identified or measured in a laboratory test.

CD4
Also known as T4 cells, CD4 cells are one of several types of T cells that are important to the immune response. They protect against viral, fungal, and protozoal infections and are the cells most susceptible to HIV. A CD4 count is an indicator of the health of patients' immune systems and thus their risk of developing opportunistic infection. Test results from a CD4 count can also be used to judge when antiretroviral therapy should begin (see T cell count).

closed systems
Closed systems are laboratory instruments that require a specific brand of reagents. Closed systems usually (but not always) cost more; they can be of higher quality because of the manufacturing practices. However, the instruments must come from a single source. Closed systems can create more medical waste than open systems.

coefficient of variation
The coefficient of variation (CV) is a measurement of the precision (or reproducibility) of a laboratory test or process. Modern instruments have a CV of 3 percent to 5 percent. When all other parameters are equal, the lower the CV, the better the test.

consumables
Consumables are items that are used once in performing a test and are not reused; for example, microscope slides and cover slips.

durables
Durables are items that can be reused for multiple tests; for example, some types of glassware that can be sterilized and reused.

ELISA test
The enzyme-linked immunosorbent assay (ELISA) is used to detect the presence of antibodies in serum. ELISA is used for first line screening for HIV antibodies; a positive result indicates that antibodies have been detected. The test is sensitive but not specific; and thus a positive ELISA is typically confirmed with a Western blot assay. In resource-constrained settings, first line screening can be done with either a rapid assay and confirmatory ELISA or a combination of rapid assays.

equipment
Instruments used in a laboratory to conduct a test are considered equipment. These items often are automated and require regularly scheduled maintenance; examples include microscopes and hematology machines. (See below for descriptions of the different systems commonly found in laboratories.)

external quality assurance
External quality assurance (EQA) is a program that allows testing sites to assess the quality of their performance by comparing their results with those of other laboratories. This is done by analyzing proficiency panels or blind rechecking. EQA also includes on-site evaluation of the laboratory to review the quality of test performance and operations.

feasibility
The feasibility of providing a specific test depends on the availability of all the elements needed to conduct the test: proper equipment; standard operating procedures; adequate quality of water and reagents; and a clean, constant power supply. The human resources are equally necessary and include adequate staffing, training, and supervision.

good laboratory practice
Good laboratory practice includes the practices, processes, and conditions required for high-quality laboratory studies to be planned, performed, monitored, and reported.

maintenance spares
Maintenance spares are often overlooked but are necessary for a functioning laboratory. Without adequate spare parts, the laboratory cannot provide reliable service. Most manufacturers can provide an accurate prediction of the type and number of parts required for a given instrument for one year.

medical technologist
A medical technologist—or clinical laboratory scientist—typically has a baccalaureate degree and a specialized internship. Many nations require certification examinations and continuing education. Some states also require licensure.

medical technician
A medical technician typically has a two-year specialized education and is supervised by a medical technologist.

open systems
Open systems are laboratory instruments that do not require a specific brand of reagents. Open systems do not rely on a single source but can use reagents from any manufacturer that develops the specifications needed for the test.

pathologist
A pathologist is a medical doctor specializing in disease or pathology.

preventative maintenance
Preventative maintenance is the sum of the tasks performed on equipment, based on the manufacturer's schedule, to prevent failure of an instrument. It is a proactive process designed to prevent testing errors from instrument failure; it is part of the quality assurance process.

quality assurance
Quality assurance (QA) manages the quality of all aspects of the testing process. QA considers pre-analytic, analytic, and post-analytic processes, such as training, interlaboratory comparison, preventative maintenance, and result reporting.

quality control
Quality control (QC) is a statistical control for precision and accuracy of laboratory results. Daily QC provides a benchmark to measure the quality of the testing process. When QC falls outside an acceptable range, the laboratory results may not be released.

reagents
Reagents are the chemical or biological substances used in laboratory testing to detect or measure an analyte (see definition). They vary widely in cost, stability, cold/cool chain requirements, availability, and associated hazards.

reference ranges
In any given population, the reference range describes the range of normal test results. For example, for adult males the normal glucose range (for a particular technique) will range from 85 mg percent to 110 mg percent. This is considered the normal range for that population.

reliability (or precision)
The reliability of a test is measured in precision. Reliability is not directly related to the sensitivity of the technique but rather to its reproducibility. For example, automated instruments provide more reliability than manual techniques. As shown by the coefficient of variation (CV)—the measurement of precision reported in percentage—automated instruments typically have a CV of less than 8 percent while manual procedures may have a CV of 15 percent or more.

sharps
Used needles and lancets, which are biohazardous and medical waste, are called sharps and must be discarded in sharps containers.

sensitivity
Sensitivity is the probability that a test is positive if the person being tested has the disease or condition. That is, high-sensitivity assays detect a high percentage of true positives. Screening tests, such as rapid HIV tests, must be highly sensitive. Screening tests may require confirmation with a highly specific test, such as the Western blot test.

specifications
Operational parameters from the manufacturer of a reagent, test, or instrument are defined in the specifications. Specifications may be found in package inserts and instrument manuals. National and international approval of reagents, tests, or instruments is based on meeting those specifications.

specificity
Specificity is the probability that a test is negative, if the person being tested does not have the disease or condition. That is, high-specificity assays detect a high percentage of true negatives. A highly specific test should be used when there is a need to minimize the number of false negatives; for example, when diagnosing an infection in an individual.

standard operating procedures
Standard operating procedures (SOPs) explain step-by-step how to do a particular test; including specimen requirements, environmental conditions, reference ranges, and reporting units. SOPs should be defined or standardized across each level of the laboratory system. For example, every district lab should have the same set of SOPs for the test techniques carried out at the district level.

standards
Standards are the concepts, procedures, and designs needed to achieve and maintain the required levels of compatibility, interchangeability, or commonality in the operational, procedural, material, technical, and administrative fields.

standardization
Standardization (in the laboratory context) is the process of ensuring that the—

- same menu of laboratory tests, defined by level of the laboratory system (central, regional, district), is offered
- same techniques, defined by level, are used to carry out those tests
- same technical SOPs are followed for those techniques
- laboratory instrumentation, defined by level, is agreed upon.

T cell (T lymphocyte)
T cells are white blood cells that stimulate the immune system to fight disease, and they are the primary target of HIV. Called T cells because they mature in the thymus gland, they include T4 and T8 cells, also known as CD4 and CD8 cells.

T cell count (CD4 count)

The T cell count is the number of T4 cells per cubic millimeter (mm^3) of blood—an mm^3 is the size of a pinhead. As HIV disease progresses, the T4 cells fall from a normal count of 500–1,500 to as low as zero. When the T cell (CD4) count goes below 200, the risk of opportunistic infections increases; when the T cell count drops below 50, the risk rises dramatically.

test menus

Test menus describe the defined list of tests that should be offered at a specific laboratory or level (central, regional, district, etc.) of the laboratory system.

usage

Usage refers to the amount of laboratory commodities consumed during a set period of time. JSI/DELIVER uses the terms *consumption* or *dispensed to user* to describe amounts of health commodities; for example, drugs. In the laboratory, usage is more appropriate because the supplies are not being consumed by or dispensed to a patient but are being used to conduct a laboratory test.

viral load

Viral load is the measurement of the number of viral particles in the circulating blood. HIV and hepatitis C are often quantified with the viral load test. Viral load and CD4 counts are both predictors of the risk of HIV disease progression. Viral load testing is also used to determine when to initiate or change antiretroviral therapy.

Western blot test

The Western blot test (WB) is a *confirmatory* test for the presence of HIV antibodies; it is only performed if the ELISA is positive. The WB can be positive, negative, or *indeterminate*, which is neither positive nor negative. An indeterminate result usually means that a person has just begun to seroconvert at the time of his or her test. In the rare cases in which this occurs, the person will need to be retested, usually about one month later. False positive results are *extremely rare* with the WB; the WB confirms that HIV antibodies are present.

SYSTEMS IN THE LABORATORY

hematology

Hematological information assesses the body's ability to carry oxygen, provide immunological surveillance, and prevent hemorrhage. Typical tests include complete blood counts, which measure the number of red blood cells, white blood cells, and platelets. Originally, these tests were done by diluting blood and counting cells, and measuring hemoglobin by comparing the color of the blood. Typically, in resource-poor settings, semi-automated instruments are used, with manual backup in the event of stockouts or instrument failure. The instruments used are almost always closed systems, using the manufacturers' reagents. When generic reagents have been used in the past, quality has suffered and most manufacturers would not support the instruments.

chemistry

Chemical information assesses the body's chemical balance. Liver function, kidney function, glucose levels, and enzyme levels are typical chemistry tests. Usually, a specific chemical reaction produces a colored product proportional to its concentration. The instrumentation can range from a very simple filter photometer to an automated testing system. Chemistry tests provide an excellent opportunity to use open systems. Reagent test kits provide high-quality reagents and standards but may be expensive. Consolidated purchasing could provide high-quality reagent kits with competitively priced bulk reagents. Many of these reagents require cold chain.

microbiology

Microbiological procedures can be either observation of stained specimens by microscope, immunological detection of antibodies to a microbe, or growth and isolation of a microorganism on agar-based media. Typical tests include malaria preps, Widal tests for typhoid antibodies, and stool cultures. These are open systems and can be labor-intensive and relatively low cost. Many microbiological media are very sensitive to absorption of water from the air and require good laboratory practice for storage and reconstitution. In a resource-limited environment, automation is usually not an option.

immunology

Classic immunological procedures could also be classified as hematological or microbiological tests. However, many new tests are based on detection of antibodies or antigens. Thus, immunology is a growing field with many new tests introduced each year. Tests for classifying white blood cells into CD type can be included as well as viral load procedures.

Classic serological tests, such as the Weil-Felix and Widal tests, are labor intensive and have some cold chain reagents. The enumeration of CD4 cells and measurement of viral load require sophisticated instrumentation, expensive labile reagents, and a high degree of training. Emerging low-cost, low-tech systems are being introduced into this dynamic field. This area requires very careful analysis of the appropriateness of any technology proposed.

urinalysis

The testing of urine is a low-technology, labor-intensive part of the laboratory. Test strip technology is used in many resource-poor settings. The test strips require good laboratory practice to prevent premature expiration.

HANDOUT 8

KEY LABORATORY TERMS QUIZ

On the answer line, write the letter from column B next to the corresponding term in column A.

Answer	Column A	Column B
	1. Closed systems	A. An item that is used once while performing a test and is not reused
	2. QA/QC	B. The development and implementation of set test menus, test techniques, and standardized operating procedures by the level of a laboratory system
	3. Durable	C. A chemical used in laboratory testing for detecting or measuring an analyte
	4. Open systems	D. A scheme that manages the quality of all aspects of the laboratory testing process
	5. Consumable	E. Laboratory instruments that require a specific brand of reagents
	6. Standard operating procedure (or SOP)	F. An item that can be reused for multiple tests
	7. Reagent	G. Laboratory instruments that do not require a specific brand of reagents
	8. Standardization	H. Instructions for performing a test, including specimen requirements, environmental conditions, reference ranges, and reporting units

HANDOUT 9

KEY LABORATORY TERMS QUIZ ANSWER SHEET

Write the letter from Column B next to the corresponding term in Column A on the Answer line.

Answer	Column A	Column B
E	1. Closed systems	A. An item that is used once while performing a test and is not reused
D	2. QA/QC	B. The development and implementation of set test menus, test techniques, and standardized operating procedures by level of a laboratory system.
F	3. Durable	C. A chemical used in laboratory testing for detecting or measuring an analyte
G	4. Open systems	D. A scheme that manages the quality of all aspects of the laboratory testing process
A	5. Consumable	E. Laboratory instruments that require a specific brand of reagents
H	6. Standard operating procedure (or SOP)	F. An item that can be reused for multiple tests
C	7. Reagent	G. Laboratory instruments that do not require a specific brand of reagents
B	8. Standardization	H. Instructions for performing a test, including specimen requirements, environmental conditions, reference ranges, and reporting units

HANDOUT 10

LOGISTICS RECORDS AND REPORTS: TYPES AND DATA

(essential data noted with *)

Stock-keeping Records	
Types of stock-keeping records: • bin cards • inventory control cards • stores ledgers	Stock-keeping data: • stock on hand* • losses and adjustments* • quantity to order • quantity on order
Transaction Records	
Types of transaction records: • requisition and issue vouchers • issue vouchers • packing slips	Transaction data: • quantity of product being ordered/shipped/received • authorization, usually by signature, to issue • proof of receipt, usually by signature • dates for all parts of the transaction
Consumption Records	
Types of consumption records: • daily activity registers • tick sheets	Consumption data: • quantity dispensed to user* • time period
Summary Reports	
For a specified time period: • quantity dispensed to user* • stock on hand* • losses and adjustments*	

Note: Each brand and formulation of each product must be reported separately.

HANDOUT 11A: FIELD STAINING TECHNIQUE

PART 1: INTRODUCTION

Your group is a district laboratory. Your group will have to work together as a team to reconstitute reagents, "conduct" malaria smears, and report on your laboratory's commodity usage. You will be given the laboratory supplies needed to conduct malaria smears with the Field staining technique. The team will need to decide how to record its logistics data. You will be asked to report on the three essential data items for the following commodities in the base unit.

NOTE: You will **NOT** be asked to determine your order requirements.

Commodities	Base Unit	Stock on Hand
Field stain A	1 g	25 g
Field stain B	1 g	25 g
Buffer tablets	1 tablet	20 tablets
Sodium azide	1 g	100 g
Sterile lancets	1 lancet	30 lancets
Crystal violet stain	1 g	25 g
Capillary tubes	1 tube	200 tubes
70% alcohol	1 mL	500 mL
Cotton balls	1 cotton ball	120 cotton balls
Vacutainer needles	1 needle	8 needles
Absolute methanol	1 mL	500 mL
Plastic disposable bulb pipettes	1 pipette	100 pipettes
Microscope slides	1 slide	70 slides
Cover slips	1 cover slip	160 cover slips
Latex gloves	1 glove	50 gloves

You have two activities to complete in the next 20 minutes:

1. Take inventory of your current stock on hand.
2. Develop appropriate LMIS (logistics management information system) forms (records and report) for recording the three essential data items for the commodities in your inventory.

Note: There are some items you will NOT be asked to report on:

- 500-mL measuring cup
- distilled water
- 1-teaspoon measuring spoon
- reagent storage bottles.

HANDOUT 11B: GIEMSA STAINING TECHNIQUE

PART 1: INTRODUCTION

Your group is a district laboratory. Your group will have to work together as a team to reconstitute reagents, "conduct" malaria smears, and report on your laboratory commodity usage. You will be given the laboratory supplies needed to conduct malaria smears with the Giemsa staining technique. The team will need to decide how to record its logistics data. You will be asked to report on the three essential data items for the following commodities in the base unit.

NOTE: You will **NOT** be asked to determine your order requirements.

Commodities	Base Unit	Stock on Hand
Giemsa stain A	1 g	25 g
Giemsa stain B	1 g	25 g
Buffer tablets	1 tablet	20 tablets
Sodium azide	1 g	100 g
Sterile lancets	1 lancet	30 lancets
Crystal violet stain	1 g	25 g
Capillary tubes	1 tube	200 tubes
70% alcohol	1 mL	500 mL
Cotton balls	1 cotton ball	120 cotton balls
Vacutainer needles	1 needle	8 needles
Absolute methanol	1 mL	500 mL
Plastic disposable bulb pipettes	1 pipette	100 pipettes
Microscope slides	1 slide	70 slides
Cover slips	1 cover slip	160 cover slips
Latex gloves	1 glove	50 gloves

You have two activities to complete in the next 20 minutes:

1. Take inventory of your current stock on hand.
2. Develop appropriate LMIS forms (records and report) for recording the three essential data items for the commodities in your inventory.

Note: There are some items you will NOT be asked to report on:

- 500-mL measuring cup
- Distilled water
- 1-teaspoon measuring spoon
- Reagent storage bottles.

PART 2: RECONSTITUTION

The first step in preparing to do malaria smears with the Field staining technique is to prepare the stock solutions. Below are the standard operating procedures (SOPs) for reconstituting Field stains A and B and for making buffered water. These solutions will be needed during the testing. All of the required supplies are on your table. You have 10 minutes for this exercise. Do not worry about being exact in your measurements.

For the purpose of these exercises:

1 g = 1,000 mg	1 teaspoon = 5 mL	1 full disposable pipette = 5 mL
1 g = 1 mL	1 teaspoon = 5 g	

1. To reconstitute 500 mL of Field stains A and B (the process is the same for each stain):
   a. Add 10 g of stain powder to the properly labeled storage bottle.
   b. Measure 500 mL of distilled water.
   c. Add the water to the stain and mix to dissolve the powder.
   d. Store the labeled bottle at room temperature. These stains have a shelf life of two months.
2. To make buffered water (pH = 7.1-7.2)
   a. Add 1 buffer tablet to 1 L of distilled water in the properly labeled storage bottle and wait until the tablet has dissolved.
   b. Add 5 g of sodium azide to the solution and mix well.
   c. Store the labeled bottle at room temperature. This solution has a shelf life of two months.
3. To make diluted Field stain B:
   a. Add 10 mL of Field stain B solution, using a plastic disposable bulb pipette, to a 30 mL container.
   b. Add 20 mL of buffered water to this solution with a plastic disposable bulb pipette.
   c. Store the bottle at room temperature. This diluted stain has a shelf life of one month.

You have two activities to complete in the next 10 minutes:

1. Mix the stock reagents according to the SOPs above.
2. Update the appropriate LMIS (logistics management information system) records.

Note: Good laboratory practice requires that you use latex gloves whenever you use laboratory products.

PLEASE NOTE THESE SOPS ARE EXEMPLARY FOR THIS EXERCISE AND ARE NOT THE EXACT AMOUNTS OF COMMODITIES NEEDED FOR THIS RECONSTITUTION.

PART 2: RECONSTITUTION

The first step when preparing to do malaria smears with the Giemsa staining technique is to prepare the stock solutions. Below are the standard operating procedures (SOPs) for reconstituting Giemsa stains A and B and for making buffered water. These solutions will be needed during the testing. All of the required supplies are on your table. You have 10 minutes for this exercise. Do not worry about being exact in your measurements.

For the purpose of these exercises:

1 g = 1,000 mg	1 teaspoon = 5 mL	1 full disposable pipette = 5 mL
1 g = 1 mL	1 teaspoon = 5 g	

1. To reconstitute 500 mL of Giemsa stains A and B (the process is the same for each stain):
   a. Add 10 g of stain powder to the properly labeled storage bottle.
   b. Measure 500 mL of distilled water.
   c. Add the water to the stain and mix to dissolve the powder.
   d. Store the labeled bottle at room temperature. These stains have a shelf life of two months.
2. To make buffered water (pH = 7.1-7.2)
   a. Add 1 buffer tablet to 1 L of distilled water to the properly labeled storage bottle and wait until the tablet has dissolved.
   b. Add 5 g of sodium azide to the solution and mix well.
   c. Store the labeled bottle at room temperature. This solution has a shelf life of two months.
3. To make diluted Giemsa stain B:
   a. Add 10 mL of Giemsa stain B solution, using a plastic disposable bulb pipette, to a 30-mL container.
   b. Add 20 mL of buffered water to this solution with a plastic disposable bulb pipette.
   c. Store the bottle at room temperature. This diluted stain has a shelf life of one month.

You have two activities to complete in the next 10 minutes:

1. Mix the stock reagents according to the SOPs above.
2. Update the appropriate LMIS (logistics management information system) records.

Note: Good laboratory practice requires that you use latex gloves whenever you use laboratory products.

PLEASE NOTE THESE SOPS ARE EXEMPLARY FOR THIS EXERCISE AND ARE NOT THE EXACT AMOUNTS OF COMMODITIES NEEDED FOR THIS RECONSITUTION.

PART 3: ONE MONTH AT THE LABORATORY

Now that your laboratory has the stock reagents required for conducting malaria smears, you are open for business! The standard operating procedures (SOPs) for conducting a malaria smear are found below. Because this is a demonstration, we will not actually be doing the tests; instead, we will do an exercise similar to the contraceptives simulation.

Every time you are asked to use a consumable item, place the item in the box labeled "biohazard: infectious waste." Every time you use some liquid reagent, place the required amount of liquid in the box labeled "sink." After the item is placed in these waste containers, it is considered to be used.

You have three activities to complete in the next 30 minutes:

1. "Perform" the tests requested at the bottom of the page.
2. Update the appropriate LMIS (logistics management information system) records.
3. Fill out your monthly report. The simulation will end on March 1, when your report is due to the central level.

Be sure to work as a team to fill out the appropriate records at the appropriate time. You will receive a 5-minute warning before the 30 minutes are over.

SOPS FOR THIN-FILM MALARIA SMEAR USING THE FIELD STAINING TECHNIQUE

1. Cleanse the ear lobe or finger using a cotton ball moistened with 70 percent alcohol. Allow the area to dry.
2. Using a sterile lancet, prick the finger or lobe. Squeeze gently to obtain a large drop of blood. Collect the blood in a capillary tube.
3. Using a microscope slide, add a small drop of blood to the center of the slide. Spread the blood on the slide using a cover slip.
4. Using a pencil, label the slide with the date and patient's name and number.
5. Allow blood to air dry.
6. Fix the thin blood film: place the slide horizontally on a level bench or staining rack. Apply a small drop of absolute methanol. Allow the film to fix for one minute.
7. Add 5 mL of diluted Field stain B to the film. Add 5 mL of Field stain A to the film. Let the two stains set for five seconds. Rinse in clean water for five seconds.
8. Place the slide in a draining rack to air dry.

TESTS REQUESTED DURING THE MONTH

February 3, 2006:	one malaria test	February 17, 2006:	two malaria tests
February 15, 2006:	three malaria tests	February 26, 2006:	one malaria test

PLEASE NOTE THESE SOPS ARE EXEMPLARY FOR THIS EXERCISE AND ARE NOT THE EXACT COMMODITIES AND AMOUNTS NEEDED FOR THIS TEST.

PART 3: ONE MONTH AT THE LABORATORY

Now that your laboratory has the stock reagents required for conducting malaria smears, you are open for business! The standard operating procedures (SOPs) for conducting a malaria smear are found below. Since this is a demonstration, **we will not actually be doing the tests;** instead, we will do an exercise similar to the contraceptives simulation.

Every time you are asked to use a consumable item, **place the item in the box labeled "biohazard: infectious waste."** Every time you use some liquid reagent, **place the required amount of liquid in the box labeled "sink."** After the item is placed in these waste containers, it is considered used.

You have three activities to complete in the next 30 minutes:
1. "Perform" the tests requested at the bottom of the page.
2. Update the appropriate LMIS (logistics management information system) records.
3. Fill out your monthly report. The simulation will end on March 1, when your report is due to the central level.

Be sure to work as a team to fill out the appropriate records at the appropriate time. You will receive a 5-minute warning before the 30 minutes are over.

SOPS FOR THIN-FILM MALARIA SMEAR USING THE GIEMSA STAINING TECHNIQUE

1. Cleanse the ear lobe or finger using a cotton ball moistened with 70 percent alcohol. Allow the area to dry.
2. Using a sterile lancet, prick the finger or lobe. Squeeze gently to obtain a large drop of blood. Collect the blood in a capillary tube.
3. Using a microscope slide, add a small drop of blood to the center of the slide. Spread the blood on the slide using a cover slip.
4. Using a pencil, label the slide with the date and patient's name and number.
5. Allow blood to air dry.
6. Fix the thin blood film: place the slide horizontally on a level bench or staining rack. Apply a small drop of absolute methanol. Allow the film to fix for one minute.
7. Add 5 mL of diluted Giemsa stain B to the film. Add 5 mL of Giemsa stain A to the film. Let the two stains set for 5 seconds. Rinse in clean water for 5 seconds.
8. Place the slide in a draining rack to air dry.

TESTS REQUESTED DURING THE MONTH

February 3, 2006:	one malaria test	February 17, 2006:	two malaria tests
February 15, 2006:	three malaria tests	February 26, 2006:	one malaria test

PLEASE NOTE THESE SOPS ARE EXEMPLARY FOR THIS EXERCISE AND ARE NOT THE EXACT COMMODITIES AND AMOUNTS NEEDED FOR THIS TEST.

HANDOUT 14

CONSIDERATIONS AND RECOMMENDATIONS FOR AN LMIS

CONSIDERATIONS

- Typically, laboratories in developing countries do not have a logistics management information system (LMIS). What they have is mostly limited to registers, does not provide required logistics data, and the information collected rarely moves beyond the facility.
- The purpose of an LMIS is often complicated by requests for additional health management information system (HMIS) data (such as test numbers).
- Maintaining daily activity registers is time- and labor-intensive. Doing this for 200 supplies may be overwhelming for laboratory staff and will more than likely be inaccurate because of the level of detail required.
- Some commodities cannot be easily quantified per test; tracking on a daily basis is, therefore, time-consuming.

RECOMMENDATIONS

- HMIS (or laboratory LMIS) data collection should be limited on the LMIS forms.
- Usage of most laboratory commodities can be tracked from the inventory as issues.
- Track a few *high ticket* tracer items, such as CD4 reagent test kits, on a daily basis. These items are supplies that are expensive, easily diverted to the illegal market or private practice, or politically important.
- Computerizing the central level to calculate reorder amounts will reduce the data analysis burden on laboratory personnel.

HANDOUT 15

MANUAL HEMOGLOBIN TESTS AND LABORATORY SUPPLIES NEEDED

Test Technique	Reagents		Consumables	Durables/Equipment
filter paper comparison			• filter/blotting paper • sterile lancet • 70% alcohol • cotton wool	• color comparison chart
copper sulfate method	• copper sulfate		• graduated transfer pipette • capillary tube • sterile lancet • 70% alcohol • cotton wool	• flasks • weighing scale • amber tinted bottles
hematocrit centrifuge			• capillary tube • graph paper • sterile lancet • 70% alcohol • cotton wool	• microhematocrit centrifuge
Lovibond comparator	• ammonia OR	• potassium ferricyanide • potassium cyanide • potassium dihydrogen phosphate • surfactant	• blood pipette • sterile lancet • 70% alcohol • cotton wool • parafilm or foil	• glass tubes • Lovibond comparator • colored glass standards
grey wedge (BMS) photometer	• saponin powder • EDTA (ethylenediamine-tetraacetic acid) powder		• toothpicks • sterile lancet • 70% alcohol • cotton wool	• BMS grey wedge photometer • glass chamber for blood sample • calibrating glass standard • batteries (1.5 volt)
Sahli method	• hydrochloric acid		• sterile lancet • 70% alcohol • cotton wool • plastic bulb pipette	• Sahli hemoglobinometer • Sahli blood pipette • dropper

Test Technique	Reagents	Consumables	Durables/Equipment
HemoCue		• cuvettes • standard cuvettes • sterile lancet • 70% alcohol • cotton wool	• HemoCue instrument • batteries
colorimetry: hemiglobincyanide method	• potassium ferricyanide • potassium cyanide • potassium dihydrogen phosphate • surfactant	• standard solution of hemoglobin • graph paper • tube labels	• photoelectric colorimeter • cuvettes • test tubes • watch or timer • calibrated pipettes
TOTAL NUMBER:	**9**	**14**	**22**

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